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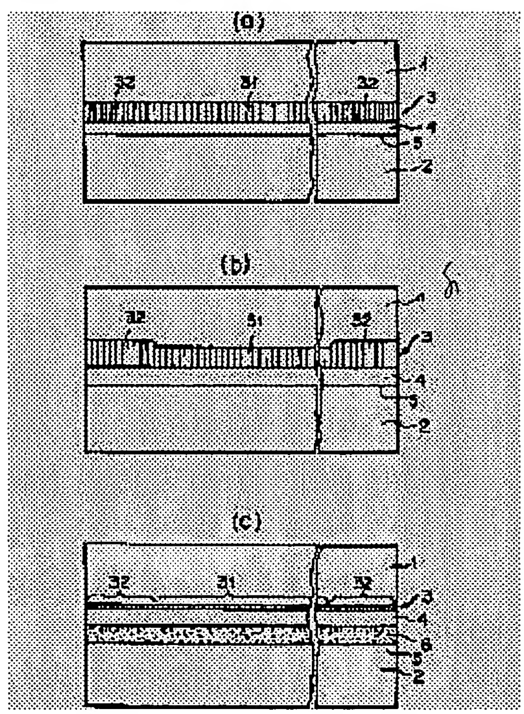
(54) COMPOUND MEMBER, ITS SEPARATING METHOD AND MANUFACTURING METHOD OF SEMICONDUCTOR SUBSTRATE USING THE METHOD



(57)Abstract:
PROBLEM TO BE SOLVED: To realize a compound member capable of being separated relatively easily, without damaging the separated substrate as well as the separating method of the compound member.
SOLUTION: In the separating method of a compound member, including the separating step of the compound member into multiple members in a separating region 3, the mechanical strength in the separating region 3 is made uneven in the direction along the laminating surface 5 to be attained by the manufacturing method of a semiconductor substrate. In particular, it is preferable that the mechanical strength in the peripheral part of the compound member in the separating region 3 be less than that in the central part. In addition, it is also preferable that the mechanical strength the separating region 3 be also less than that in the laminated location.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the manufacture approach of a semi-conductor base at the separation approach list which separates the compound member a compound mechanical strength has the weak brittle structured division inside about the manufacture approach of a semi-conductor base in a compound member and its separation approach list, and it. Especially this invention is suitable for the process of the substrate (SOI substrate) which has the SOI (Semiconductor on insulator) structure which is a kind of a semi-conductor base.
[0002]
[Description of the Prior Art] The device which adopted this SOI substrate has many dominance points which cannot be attained in the usual Si substrate. As this dominance point, the following are mentioned, for example.
(1) Dielectric separation is easy and suitable for high integration.
(2) Excel in radiation resistance.
(3) Stray capacity is small and improvement in the speed of the working speed of a component is possible.
(4) A well process is unnecessary.
(5) A latch rise can be prevented.
(6) Formation of the perfect depletion mold field-effect transistor by thin-film-izing is possible.
[0003] Since SOI structure has above various dominance points, research on the formation approach has been advanced for here dozens years.
[0004] as a SOI technique -- old -- a single crystal silicon-on-sapphire top -- Si -- CVD (chemistry gaseous layer growth) -- the SOS (silicon on sapphire) technique which is made to carry out hetero epitaxy growth and is formed by law is known. Although this SOS technique obtained assessment temporary as a SOI technique which matured most, utilization is not progressing for the reasons of generating of the crystal defect of the large quantity by the grid mismatching in the interface of Si layer and the silicon on sapphire of a substrate, mixing to Si layer of the aluminum which constitutes silicon on sapphire, the price of a substrate, the delay to large-area-izing, etc.
[0005] Subsequently to an SOS technique, the SIMOX (separation by ion implanted oxygen) technique appeared. Aiming at reduction of a crystal defect, reduction of a manufacturing cost, etc., various approaches have been tried about this SIMOX technique. On both sides of the approach and oxide film which pour in and embed oxygen ion as this approach at a substrate, and form an oxidizing zone, stick two wafers, and the wafer of 1 in all side is ground or etched. the approach of leaving a thin single crystal Si layer on an oxide film -- further After driving a hydrogen ion into the predetermined depth from the front face of Si substrate in which the oxide film was formed and sticking with the substrate of another side, it leaves a thin single crystal Si layer on this oxide film by heat-treatment etc., and the approach of exfoliating the stuck substrate (substrate of another side) etc. is mentioned.
[0006] A new SOI technique was indicated in the patent No. 2608351 official report or U.S. Pat. No. 5,371,037. This technique transfers a nonvesicular single crystal layer to the second substrate by removing a garbage for the first substrate in which the nonvesicular single crystal layer was formed on the single crystal semiconductor substrate with which the porous layer was formed, lamination and after

that to the second substrate. This technique is excellent in respect of the ability to manufacture [that the thickness homogeneity of a SOI layer is excellent, that the crystal defect consistency of a SOI layer can be reduced, that the surface surface smoothness of a SOI layer is good, that the manufacturing installation of an expensive special specification is unnecessary,] the SOI substrate which has the SOI film of the range which is several 10nm - about 10 micrometers by the same manufacturing installation.
[0007] Furthermore, these people dissociated from the second substrate, without destroying the first substrate in JP,7-302889,A, after sticking the first above-mentioned substrate and second above-mentioned substrate, after that, are making the front face of the first separated substrate smooth, and forming a porous layer again, and indicated the technique which reuses the first substrate. One example of the approach indicated by the official report concerned is explained using drawing 12 (a) - drawing 12 (c). After porosity-izing the surface layer of the 1st Si substrate 1001 and forming a porous layer 1002, the single crystal Si layer 1003 is formed on it, and the principal plane of 2nd Si substrate 1004 with another this single crystal Si layer and first Si base is stuck through an insulating layer 1005 (drawing 12 (a)). Then, a SOI substrate is formed by dividing the wafer stuck by the porous layer (drawing 12 (b)), and removing selectively the porosity Si layer exposed to the front face by the side of 2nd Si base (drawing 12 (c)). The first Si substrate 1001 can remove and reuse the porous layer 1002 which remained.
[0008] Invention indicated by JP,7-302889,A is very useful when attaining low cost-ization of a semi-conductor substrate, since the substrate with which the structure of a porosity silicon layer dissociates and used the substrate for the production process of a semi-conductor substrate once using the brittle point compared with nonvesicular silicon can be again used for the production process of a semi-conductor substrate. Moreover, since the first substrate can be used for this technique without futility, it can reduce a manufacturing cost substantially and has the outstanding advantage that a production process is also simple.
[0009] As an approach of separating the first base (substrate) of the above, and the second base (substrate) Others [approaches /, such as application of pressure, hauling shear, wedge insertion, heat treatment, oxidation, wave-motion impression, and a wire cut,], There is an approach which this invention persons spray the fluid proposed in the application number 047 or No. 327 for which it applied to the U.S. on an isolation region, and separate on Japanese Patent Application No. No. 75498 [nine to] and March 25, 1998. As this fluid, a gas and/or a liquid are used and the water jet using the liquid which uses especially water as a principal component etc. can use it preferably. On the occasion of separation, this approach enters uniformly the clearance between not only an operation but the first base and the second base with which water cuts a lamination side, and can put a comparatively uniform separation pressure on the whole separation side. Moreover, this approach cannot sprinkle particle like [in the case of a gas], but can flush it rather. The approach of separating by wedge insertion is excelled in these two points. When especially the mechanical strength of an isolation region is made brittler than a lamination part, by spraying the flow of a fluid on this, only a brittle part is fractured, destroyed or removed and the part with the other strong reinforcement has the big advantage that it can leave without being destroyed.
[0010]
[Problem(s) to be Solved by the Invention] However, if the reinforcement of an isolation region is strong when it is going to separate the stuck compound member using fluids, such as a water jet, and a fluid is sprayed a side face, especially near an isolation region side face a compound member, flow of a fluid may be unable to destroy or cut an isolation region easily. In such a case, although it can dissociate by heightening the pressure of a fluid, if a pressure is made high too much, as the crack advances inside from the side face of a lamination base, it may be divided for the pressure of the fluid with which both both [one of the two or] which were separated were poured into the isolation region. For this reason, yield lowering might occur in the separation process. Although one approach for avoiding this is weakening the mechanical strengths of all isolation regions further, and making it brittler structure, when it weakens too much, an isolation region breaks during the handling of the base of the heating process and washing process in the middle of a compound member creation process, and others, it may not result in lamination, or an isolation region may collapse, particle may occur and it may become a pollution source.
[0011] Moreover, since the same problem arises fundamentally also when it is going to dissociate by

other approaches without using a fluid, the yield in a separation process may fall.
[0012] The object of this invention is to offer the compound member which can separate a compound member comparatively easily, and its separation approach, without damaging the separated base.
[0013] Another object of this invention is to offer the compound member which the mechanical strength of an isolation region could be strengthened comparatively, suppressed breaking which an isolation region does not mean, and suppressed generating of particle, and its separation approach.
[0014]
[Means for Solving the Problem] This invention can be attained by the manufacture approach of the semi-conductor base characterized by the uneven thing in the separation approach of a compound member including the process which divides a compound member into two or more members in an isolation region in the direction in which the mechanical strength of an isolation region met the front face of a compound member.
[0015] It is desirable that the mechanical strength of the compound member periphery of said isolation regions is especially weaker than a center section. Moreover, as for said isolation region, it is simultaneously desirable that a mechanical strength is weaker than said lamination part.
[0016] This isolation region can use the layer which can obtain the very small air bubbles formed of the porous layer formed by the anodization method, or ion implantation. When using semi-conductor bases, quartz wafers, etc., such as Si wafer, as the first base of the above, or the second base, although these have the orientation flat and the notch, since it is disc-like in general, said compound member which sticks these first bases and the second base of each other, and changes is also outline discoid. In such a case, the mechanical strength of said isolation region has the high heterogeneity to which it becomes low by the periphery in the core in this compound member, and the in general more uniform one is divided into a circumferencial direction good. When a compound member is rectangular plate-like part material, the mechanical strength of the corner, one side, or the perimeter is weakened.
[0017] A mechanical strength can be made into an ununiformity by forming in said isolation region the part from which porosity differs mutually. Since a mechanical strength becomes weak so that porosity is enlarged, a mechanical strength is changed by changing porosity. The mechanical strength in the periphery can be weakened by more specifically making porosity higher than a center section at a periphery.
[0018] Said isolation region can make a mechanical strength an ununiformity also by changing the thickness. Since a mechanical strength becomes weak, a mechanical strength also changes by changing the thickness, so that thickness of said isolation region is thickened. Therefore, the porous layer of said isolation region can weaken the mechanical strength in the periphery also by making the thickness at a periphery larger than the center section of the base.
[0019] In order to obtain the compound member which was more suitable although separation does not take place at the process before the separation process of said compound member but it dissociates certainly at a separation process, it is more desirable to form said isolation region from two or more layers from which a mechanical strength differs. It is desirable that the porosity which adjoins a nonvesicular single crystal half conductor layer makes thickness of a layer with high porosity thinner than the thickness of a low layer into said isolation region which consists of two or more above-mentioned layers especially. There is not necessarily no need that the structure of each layer in it changes steeply in the interface, as for two or more above-mentioned layers. Though it is changing continuously by the interface of adjacent layers, it becomes easy to separate the reinforcement and structure of each class rather than reinforcement is uniform over the whole isolation region.
[0020] In said isolation region which consists of two or more layers from which said mechanical strength differs, it is more desirable that the porosity of a layer with said high porosity is more higher than near the center section of the base at a periphery.
[0021] When forming said isolation region which consists of a field of the shape of two or more layer where said mechanical strengths differ, the porosity which is the 2nd layer with said large porosity can be made at a periphery larger than the center section of the base by making at a periphery thickness which is the 1st layer with said small porosity larger than the center section of the base.
[0022] this invention persons were conducting the experiment which performs various modification to anode plate degassing equipment that a good porous layer should be formed. It found out then that there

was an Si wafer which has the field interior division cloth of porosity in two or more Si wafers which performed porosity-ized processing using the anode plate degassing equipment of a certain gestalt.
[0023] Moreover, it turned out that the sample in which the nonvesicular layer was formed on the porous layer is prepared, and there is a sample which can exfoliate more easily from what has comparatively high porosity even if the porosity of a porous layer is comparatively low, when the experiment which exfoliates the nonvesicular layer is conducted.
[0024] If it sets to the porous layer to which porosity has field interior division cloth like the operation gestalt mentioned later based on the two above-mentioned knowledge and the layer of high porosity fractures or collapses comparatively, the layer of low porosity will also be fractured comparatively easily and it will not receive effect in the absolute value of porosity so much.
[0025] That is, when there is a layer of high porosity relatively [periphery / which is easy to make separation start / of a member], irrespective of the absolute value of the porosity, it finds out that separation becomes easy and came to make this invention.
[0026]
[Embodiment of the Invention] Drawing 1 (a) - drawing 1 (c) are the sectional views of the compound member by the gestalt of 1 operation of this invention.
[0027] As a compound member is shown in drawing 1 (a), the first base 1 and second base 2 stick mutually, are set, and are formed, and the isolation region 3 is formed in the interior. Here, the first base 1 has a lamination interface in the place which is contacted on the front face of the second base 2, is stuck, and shows the layer 4 formed on the isolation region 3 to a sign 5.
[0028] The mechanical strength has the comparatively strong part 31 and the weak part 32, and an isolation region 3 has the part 32 with a weak mechanical strength in the periphery (periphery of an isolation region) of a compound member.
[0029] Since the weak part 32 of a mechanical strength exists in the periphery of a compound member relatively when separating this compound member, a crack or breaking arises into this part 32 previously, and it becomes easy to separate a compound member.
[0030] For explaining in more detail, drawing 1 (a) formed the part 32 which consists of a porous body with high porosity in the periphery of the isolation region 3 where thickness is uniform, and has formed the weak part 32 of a mechanical strength locally at the periphery by forming the part 31 which consists of a porous body with low porosity in the center section. Drawing 2 (a) shows the location of the strong part 31 of the mechanical strength at the time of seeing this compound member from a top face, and the weak part 32. A sign 7 is an orientation flat prepared if needed.
[0031] Moreover, the weak part 32 of a mechanical strength may be a part of periphery section, as shown in drawing 2 B instead of all the peripheries of a compound member. It is desirable to make area of the strong part 31 of a mechanical strength sufficiently larger than the area of the weak part 32.
[0032] Drawing 1 (b) is making into an ununiformity thickness of the isolation region 3 which consists of a porous body of uniform porosity, and forms the weak part 32 of a mechanical strength in a periphery. As the flat surface of an isolation region 3 is shown in drawing 2 B also in this case, it may be locally formed in a part of periphery section.
[0033] Drawing 1 (c) forms the weak part 32 of a mechanical strength by ion implantation by forming a part with many amounts of ion implantations in a periphery. Also in this case, as shown in drawing 2 (b), the amount of ion implantations can be locally made [many], and the weak part 32 of a mechanical strength can also be formed in a part of periphery section. Since very small air bubbles will arise if a hydrogen ion and rare gas ion are driven in and predetermined heat treatment is performed, the part by which the ion implantation was carried out to high concentration can also be made into a porous body with high porosity.
[0034] Both, the weak part 32 of a mechanical strength is higher than other parts, is thickening and may form the porosity and thickness of a porous body locally. Moreover, ion may be locally driven into the isolation region which consists of a porous body, the porous body of the part by which the ion implantation was carried out may be made brittle, and a mechanical strength may be weakened.
[0035] That is, it is also desirable to combine suitably the description part of a configuration of to have been shown in drawing 1 (a) - drawing 1 (c).
[0036] As the first base 1 used for this invention, tabular semi-conductor wafers other than Si wafer,

such as germanium, SiGe, SiC, GaAs, GaAlAs, and InP, GaN, are used preferably.
[0037] As the second base 2, you may be insulating bases, such as quartz glass and a resin sheet, and metallicity bases, such as stainless steel, besides the same semi-conductor wafer as the first base 1.
[0038] The monolayer or two or more layers which consist of an ingredient chosen from the same semiconductor material as the ingredient of the first base as a nonvesicular layer are used preferably. When separating composite material and producing a SOI substrate, it is desirable that it is a single crystal half conductor layer.
[0039] What was formed with different ingredients from a layer 4, such as an insulator or a conductor, as a layer 6 shown in drawing 1 (c) is used preferably.
[0040] And when sticking the first and the second base, it is desirable to also make an insulating layer and the layer of adhesives intervene in between.
[0041] Drawing 3 (a) and drawing 3 (b) are graphs which show relatively distribution of the mechanical strength within the field of a compound member.
[0042] The part from a certain location LE 2 which a mechanical strength increases a continuous line 107 from the left periphery edge LE 1 of a compound member gradually toward the right periphery edge RE1 of a compound member to the center O toward Center O, and includes Center O to a location RE2 is the gestalt which a mechanical strength is the strongest and is fixed.
[0043] An alternate long and short dash line 108 is a gestalt in which the mechanical strength has changed intermittently between the periphery section (part from [from the periphery edge LE 1 to a location LE 2] the periphery edge RE1 to a location RE2), and a center section (from a location LE 2 to a location RE2).
[0044] A broken line 109 is a gestalt which the mechanical strength is increasing from the periphery edges LE1 and RE1 continuously towards Center O, and, as for a mechanical strength, takes maximum in the Center O.
[0045] In this invention, it is desirable that the mechanical strength in the part from the location of the method of the inside of 5mm to the periphery edge of an isolation region weakens locally rather than the mechanical strength in a center section toward a center from the periphery edge of a compound member. If it is made to correspond to drawing 3 (a), it is desirable to form an isolation region as a film so that the location of the method of the inside of 5mm may consist of a periphery edge of a compound member toward a center between LE1 and LE2 and/or between RE2 and RE1.
[0046] Furthermore, when separating the compound member of the diameter of macrostomia from the periphery edge toward the center, it may be unable to dissociate so that the center section of the compound member may wish. In this case, it is good to form the weak part of a mechanical strength in the center locally.
[0047] Drawing 3 (b) shows an example of such a gestalt, and the high part of a mechanical strength is the doughnut-like part M between a periphery and a center.
[0048] As an isolation region, when using a porous layer, it is good for a mechanical strength to make the porosity of a weak periphery 35% or more more preferably 20% or more, and to make the upper limit of porosity 80% or less. Although the porosity of the center section where a mechanical strength is strong should be just lower than a periphery, it is good to choose desirably, so that it may become it is more desirable and lower than 5% or more of less than 20% of within the limits to a periphery less than 35% 5% or more.
[0049] If there is 10% or more of differences of porosity more preferably 5% or more, the difference of sufficient mechanical strength to divide a compound member into a periphery and a center section easily will be acquired.
[0050] Moreover, what is necessary is just to make the porosity of the part in which this part M, i.e., a mechanical strength, has the maximal value in making an isolation region from a porous body, since it becomes a part with the part strong [a mechanical strength] which shows with Sign M in the case of drawing 3 (b) more preferably as low as less than 20% 5% or more less than 35% 5% or more as well as the center section of drawing 3 (a).
[0051] The porosity of the center O in drawing 3 (b) is good to choose from 20% - 80% of range suitably that what is necessary is just more highly than Part M, so that the relation may be filled.
[0052] Porosity [of a porous body] P (%) expresses the rate of the volume which a hole occupies in the

volume of the appearance of a porous body here. This porosity is expressed with the following formula using the consistency m of a porous body and the consistency M of a nonvesicular object which were formed on said 1st base.

[0053]

P={(M-m) /M} x100 (%) (1)

Here, weight G of the appearance of the porous-layer object containing a hole is **(ed) by the volume V of the appearance of the porous body containing a hole with the consistency m of a porous body. m=G/V (2)

It comes out. In order to ask for the porosity P of the porous layer of the base which actually has a layer system only whose depth d by the side of a front face is a porous body, it can ask from a degree type using the weight B of the base after removing thoroughly the weight a and the porous layer of said base after forming the weight A and the porous layer of a base before forming a porous layer.

[0054]

P={(A-a)/(A-B)} x100 (3)

Next, the production approach of a compound member is described.

[0055] First, the first base 1 like Si wafer is prepared, and an isolation region 3 is formed in the part of the predetermined depth from the front face or a front face. There is the approach of forming in the part of the predetermined depth the ion implantation layer from which impregnation ion concentration serves as max from the front face of the first base 1 by carrying out the ion implantation of the different ion from the configuration element of a base like the approach and/or hydrogen ion which porosity-ize the front face of the first base 1 by anodization etc., or rare gas ion as a method of forming an isolation region. By controlling the conditions of anodization, and the conditions of ion implantation by the below-mentioned procedure, the weak part of a mechanical strength is made to a periphery.

[0056] Next, the nonvesicular layer 4 is formed on an isolation region 3 if needed, and it sticks on the 2nd base. In using ion implantation, the surface of the first base turns into the nonvesicular layer 4 as it is. In using porosity-ization, it forms a layer 4 by sputtering or CVD on the front face of the first porosity-ized base 1.

[0057] And the nonvesicular layer 4 is stuck on the 2nd base like Si wafer through an insulating layer 6 direct or if needed. In this way, a compound member is done.

[0058] One approach with being such for forming the weak porous layer of a mechanical strength locally is changing the current density of anodization in a field. the formation which flows into the periphery of a semi-conductor base -- by making current density high in the periphery of a base, it is thicker than the center section of the base, and the thickness and/or the porosity in a periphery of a base of said porous layer can be made high. In order to realize the above current density distribution, it is making the cross section to which the ion current in anodization liquid [/ near the base degassed] flows in the case of anodization larger than the area of the base to degas. the formation which flows into a base periphery by this -- the formation which flows the surface density of a current in the center of a base -- what is necessary is just to make it larger than the surface density of a current What is necessary is to enlarge and for a base just to receive the ion current of the cross section larger than the area of a base from the base which degases specifically used **********.

[0059] Drawing 4 shows notionally the equipment used for anodization. As for the DC power supply for anodization in 101, and 102, in drawing 4 , a cathode electrode and 103 are anode electrodes. 104,105 is an insulating supporter holding the processed base 1, and carries out the engagement of the base 1 in a crevice. 106 is an insulating layer pars basilaris ossis occipitalis.

[0060] here -- the area of an electrode 102,103 -- 1.2 time [of the area of a base 1] - they are 1.3 times to about 2.0 times more preferably 3.0 times.

[0061] If it is made this appearance, in case the ion which has flowed from an outside [edge / of a base / periphery] will be brought together in a base, it flows in mostly by the periphery of a base, and it is large in the thickness of the porous layer of that part, and porosity can be made high.

[0062] Furthermore, it is possible to perform two or more steps of anodization, to make thickness of the periphery of the 1st porous layer thicker than a center section, and to make higher than the porosity of a center section the porosity of the periphery of the 2nd porous layer which this forms after that.

[0063] When distribution of such an inrush current needs to be further controlled to a precision, the

current guide which controls the ion current distribution which flows into a base front face near the base to degas can be prepared, and distribution of the thickness of a layer with said small porosity can be controlled by controlling ion current distribution.

[0064] In using the layer which can obtain the very small air bubbles (microcavity) formed of said ion implantation as said isolation region, by making the consistency of ion implantation high, the magnitude and the consistency of the above-mentioned very small air bubbles, thickness over which very small air bubbles are distributed can be enlarged, and, thereby, it can make the mechanical strength of this field small.

[0065] Then, it is possible by making the amount of ion implantations of a base periphery larger than a base center section to raise the very small air-bubbles consistency per unit volume of a base periphery, and to make porosity higher than a base center section.

[0066] Drawing 5 is a graph which shows the field interior division cloth about the diameter direction of the porosity of the porosity acquired by the approach as shown in drawing 4 .

[0067] Since a mechanical strength becomes weak so that porosity becomes high, compared with the continuous line 107 of drawing 3 (a), the continuous line 207 and dotted line 209 of this drawing 5 are the pattern of vertical reverse from this graph.

[0068] If the ratio of the area of an electrode 102,103 to the area of a base is large enough, it will become like a continuous line 207, and when the ratio of the area of an electrode to the area of a base is small, there is an inclination which becomes like a broken line 209. In this way, the porous body of high porosity can be formed in a periphery.

[0069] The technique of on the other hand making the porous layer of mechanical-strength distribution as shown in the alternate long and short dash line 11 of drawing 1 (a) and drawing 3 (a) is described. The 1st approach is as follows. The photoresist pattern used as the mask for ion implantations is prepared only in the periphery section of a base 1, and boron ion is injected into a center section. Anodization using the electrode of the almost same area is given with a base to the base with which the boron ion concentration of the periphery section became low locally, and a center section makes [the periphery section] the porous layer of low porosity from high porosity.

[0070] The 2nd approach is as follows. Except for the periphery section of a base, anodization-proof masks, such as a wax, perform general anodization for a center section under the conditions of a bonnet and high current density, and the periphery section is porosity-ized.

[0071] Next, the mask of the periphery section is carried out, general anodization is performed under the conditions of a low current consistency, and a center section is porosity-ized.

[0072] The 3rd approach also has the approach only the periphery section raises porosity by ion implantation, after forming a uniform porous layer by general anodization. If the amount distribution of ion implantations is controlled, a porous layer with intensity distribution as shown in drawing 3 (a) and drawing 3 (b) can be formed with a sufficient controllability.

[0073] However, probably, in respect of a manufacturing cost, the approach shown in drawing 4 will be more advantageous than these approaches.

[0074] Next, the production approach of the compound member shown in drawing 1 (c) is described more concretely.

[0075] A base like Si wafer is oxidized and an insulator layer 6 is formed. The ion implantation of hydrogen or the rare gas ion is carried out to the whole base surface with predetermined acceleration voltage. Ion is driven in for the center section except the periphery section with the again same acceleration voltage as a bonnet and the periphery section with a photoresist mask pattern. In this way, the isolation region 3 with the weak part 32 of a mechanical strength can be formed.

[0076] A mask pattern is removed and an insulator layer 6 is stuck on the second base 2. A mechanical strength should just set heteroatom concentration of a weak part to 1020cm-3-1023cm-3, using a dose [in / for the dose in the 1st ion implantation / the 2nd ion implantation] as 1015cm-2-1017cm-2, respectively.

[0077] Next, the separation approach of the compound member used for this invention is explained. As shown in drawing 6 (a), a compound member is divided into explaining the gestalt which separates the compound member shown in drawing 1 (a) as an example using the internal stress generated by heat treatment etc., and external force. Among isolation regions 3, since a periphery 32 has a locally weak

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mechanical strength this collapses first or a crack produces it first here. Drawing 6 (a) shows signs that apply the force 111 which inserts a wedge 110 and pulls apart the periphery of the first base 1 from the second base 2, and it dissociates.

[0078] And a compound member is divided into two as shown in drawing 6 (b). When the residual layer 37 of the isolation region 3 which remains on the nonvesicular layer 4 is comparatively thick, polish and etching remove a residual layer. And it heat-treats in a hydrogen ambient atmosphere if needed (hydrogen annealing). In this way, the base 2 equipped with the layer 4 which has a smooth front face as shown in drawing 6 (c) is obtained.

[0079] In the case of the application of a solar battery etc., it is not necessary to remove a residual layer.

[0080] As the separation approach of said usable compound member, to this invention Application of pressure, hauling which are indicated by JP,7-302889,A, Various approaches, such as shear, wedge insertion, heat treatment, wave-motion impression, and a wire cut, and said the first base and second base which were stuck which were proposed by Japanese Patent Application No. No. 75498 [nine to] by spraying a fluid near the side face of said isolation region The approach of dividing into two or more members in a different isolation region from a lamination interface is usable.

[0081] In order to dissociate in this invention, the flow of the fluid to be used is realizable by injecting the pressurized fluid from a thin nozzle. as the approach for making flow to inject into a high speed and a high-pressure narrow beam more -- "a water jet" -- a fluid jet process which is introduced to the 4th page per volume [1st] No. etc. can be used. Fluid jet usable to this invention is 100 pressurized by high pressure pumping - 3000 kgf/cm2. By injecting a high-pressure liquid from a nozzle with the thin diameter of about 0.1-0.5mm, cutting (however, an abrasive material is added to water at the time of a hard ingredient) of the ceramics, a metal, concrete, resin, rubber, timber, etc., processing, clearance of a surface paint film, washing on the front face of a member, etc. can be performed. In how to use the conventional water jet, it was the main effectiveness to remove some ingredients as mentioned above. That is, carrying out water jet cutting only in that for a principal piece, and removing ** and clearance of a paint film, and washing on the front face of a member were removing an unnecessary part.

[0082] As the formation approach of the flow of the fluid of this invention, when using a water jet, it is possible by injecting a water jet on the side face of said isolation region to separate a compound member. In this case, said isolation region side face is first exposed on the side face of a lamination base, and a direct water jet is injected on there and the outskirts of it. Then, each base does not receive breakage, but only the isolation region where mechanical strength is brittle is removed by the water jet, and the base of two sheets is separated. Moreover, said isolation region side face is not exposed beforehand by a certain reason, and even when the part is covered by film like an oxide film, after removing a wrap layer for an isolation region first by the water jet, it can dissociate by the water jet.

[0083] Moreover, although it is the effectiveness which was not used in the conventional water jet, by injecting jet to the crevice of the side face of a compound member, said isolation region where structure is brittle can be extended, it can destroy, and a lamination wafer can also be separated. In this case, it is possible to dissociate without giving a damage on the surface of separation, without using abrasives, even if the cutting waste of an isolation region is hardly generated and an isolation region cannot remove with the jet itself as a raw material.

[0084] Thus, this effectiveness can also be considered to be the effectiveness of a kind of same wedge as what was shown in drawing 6 (a) by the fluid instead of effectiveness, such as cutting and polish. Therefore, by a crevice's having this effectiveness in the side face of a lamination base, and injecting jet, when the force is applied in the direction which lengthens and removes an isolation region, effectiveness can be expected very much. It is more desirable for the configuration of the side face of a compound member to be not a convex type but a concave, if it is fully going to demonstrate this effectiveness.

[0085] Drawing 7 is the outline perspective view showing an example of the water jet equipment used for the manufacture approach of the semi-conductor base used for this invention. In drawing 7 , a sign 1 is the compound member which carried out the lamination unification of the two Si wafers, and an isolation region 3 exists in the interior. 403,404 is the holder which adsorbs / fixes the compound member 1 by the vacuum chuck, and exists on the same revolving shaft mutually. Furthermore, a holder 404 can be rotated at the speed of arbitration by connecting with susceptor 409 through a bearing 408, and the speed-control motor 410 linking directly and being connected in the rear. Moreover, the holder

403 was connected with susceptor 409 through the bearing 411, and the force is applied in the direction YA in which a holder 403 separates from the compound member 1 by minding a compression spring 412 between susceptors 409 in the rear.
[0086] First, it sets so that the compound member 1 may be learned from a gage pin 413, and it is made to adsorb/hold at a holder 404. if a holder 404 is about the compound member 1 at a gage pin 413 -- **** -- it is things and compound member 1 center section can be held. Next, the compound member 1 learns it from a bearing 411, and advances it leftward until it adsorbs / holds a holder 403. As for a holder 403, at this time, the force takes rightward by the compression spring 412. As for the appearance which a holder 403 does not separate from the compound member 1 by the force by the compression spring 412, the force in which a compression spring 412 returns, and the force in which a holder 403 attracts the compound member 1, balance is maintained at this time.
[0087] Next, it continues taking out during 1 scheduled time until it sends water into the water jet nozzle 402 from the water jet pump 414 and the water to spout is stabilized. If water is stabilized, the water (following water jet water) which opened the shutter 406 and was spouted from the water jet nozzle 402 on the side face of the compound member 1 ~~will be~~ hit. At this time, the compound ~~member 1 and a~~ holder 403 are rotated by rotating a holder 404. In the side face of the compound member 1, water jet water is hitting near the core of the thickness, it extends the compound member 1 from the periphery section to two bodies toward a core, destroys a comparatively weak isolation region within the compound member 1, and divides it into two bodies eventually.
[0088] Like, after [which was mentioned above at this time] dissociating since the force is working rightward while water jet water is uniformly poured on the compound member 1 and a holder 403 holds the compound member 1, it is the device in which compound member 1 separated comrades do not slide.
[0089] Moreover, a liquid with the operation which does not use water but etches selectively the isolation region of alkali and others, such as acids, such as organic solvents, such as alcohol, and fluoric acid, a nitric acid, or a potassium hydroxide, as a fluid to be used etc. is usable. Furthermore, gases, such as air, nitrogen gas, carbon dioxide gas, and rare gas, may be used as a fluid. Gas and the plasma which have an etching operation to an isolation region can also be used. As for the water to be used, for the separation approach of the compound member introduced into the production process of a semi-conductor base, it is desirable to use water with the high purity of the pure water from which an impurity metal, particle, etc. were removed as much as possible, ultrapure water, etc. Moreover, if it washes after separation even if it uses fluid jet other than pure water, since it is a perfect low-temperature process, an impurity and particle can also be removed enough.
[0090] When using the approach of spraying such a fluid, it is desirable to give the configuration where it cratered in a concave which produces the force of the direction which extends an isolation region in response to the flow of a liquid near the isolation region of said compound member. When it is going to separate the compound member with which the base of two sheets sticks and it comes to unite it across an isolation region in an isolation region, such structure can be easily realized by beveling the edge of each base.
[0091] When applying separating power to the isolation region currently beforehand formed in the compound member the flow of a fluid like a water jet, or by using the various approaches of application of pressure, hauling, shear, wedge insertion, heat treatment, wave-motion impression, a wire cut, and others and separating into two, separation advances by [of an isolation region] destroying a brittle part mechanically. Also when the flow of a fluid is injected near an isolation region, the flow of a fluid removes or destroys the isolation region where a mechanical strength is brittle. And since the other part which is not brittle remains without being destroyed an isolation region being removed fundamentally [in the case of a fluid], there is an advantage that it can dissociate without damaging the part used after separation as a result. However, in the case of [neither of] the approaches, an isolation region may be unable to be destroyed if the reinforcement of an isolation region is not weak enough. For example, an isolation region may be unable to be destroyed or removed by the flow of the fluid of a predetermined pressure.
[0092] In order to solve this, when the pressure of a fluid is heightened, it is destroyed to the other part but not only an isolation region, for example, in separation of a lamination base, the tabular first or the

second base may break. If the pressure of a fluid is lowered in order to prevent this, the dilemma that separation is impossible will arise.

[0093] It is necessary to stuff a solid wedge into the isolation region of the part formed in the periphery of a near [the front face of the isolation region formed into the compound member at the initial stage of separation (for example, a disc-like lamination base)] by the separation approach of above most. Thus, it is necessary to advance separation from a front face in many cases. However, the part near a front face has the problem that the area which applies separating power is small while separation does not advance, and the area consistency of the force must be made high. Although this can apply separating power to the separated field, it is because separating power cannot be applied to the field which has not been separated yet. In the phase in which separation advanced, since the area which can apply separating power increases and the surface density becomes low even if it makes it easy to enlarge separating power applied to a separation side, and to separate, it becomes easy to prevent breakage (crack etc.) of the base accompanying separation.

[0094] Before thickening thickness of a porous layer which raises the porosity of the porous layer of an isolation region, or reaching a separation process in the middle of the formation process of said compound member in the early stages of separation by increasing the amount of formation of very small air bubbles by increasing the amount of ion implantation etc. if reinforcement becomes weak too much, although what is necessary is just to weaken mechanical strength in order to make separation easy, the inconvenience that an isolation region is destroyed arises.

[0095] It became clear that this invention persons changed the mechanical strength of an isolation region in the direction parallel to a lamination side, and should just weaken the mechanical strength of the part near the lamination base front face of said isolation region, for example, a periphery, compared with a base center section especially in order to avoid such inconvenience as a result of wholeheartedly research.

[0096] In the phase where the area of the field separated by the initial stage of separation cannot enlarge separating power small, the mechanical strength of an isolation region is weakened and separation is made to advance by the small force. This is possible by making small the mechanical strength of the isolation region near the periphery of a base. In the center section of the base, the mechanical strength of an isolation region is made higher than a periphery, and peeling in the middle of a process is prevented.

[0097] In this way, since the area which separation put in the center section and was separated at this time is large even if it sets, even if it makes surface density of separating power small, the whole separating power becomes large and can advance separation. Such effectiveness has the most desirable approach of injecting the flow of the above-mentioned fluid to an isolation region, in order to prevent breakage of a base, applying separating power to homogeneity comparatively in the whole field separated although it is not based on the separation approach but is demonstrated.

[0098] In order to make large the condition range for being stabilized and performing separation and to ensure separation without breakage of a base, the structure where an isolation region 3 consists of the field (22 23) of the shape of two or more layer where mechanical strengths differ like drawing 8 is desirable. In such a case, making the mechanical strength in a periphery small compared with the center section of the base can be realized comparatively easily. the case where the isolation region has a laminated structure of the layer 23 (this is called the porous layer first pass for convenience.) with small porosity, and the large layer 22 (this is called for convenience the second layer of a porous layer.) -- the layer 23 with small porosity -- first -- an anodization method -- forming -- after an appropriate time -- formation -- what is necessary is to enlarge a current and just to form the layer 22 with large porosity by the anodization method similarly

[0099] As for the porosity of 22, according to the place which this invention persons studied wholeheartedly, it turned out that it was not decided only by the magnitude of a current and is dependent also on the thickness and the porosity of the above-mentioned porous layer first pass 23 the second layer of the above-mentioned porous layer. the above-mentioned porous layer second -- formation of layer 22 -- even if it sets up a current equally, when the thickness of the above-mentioned porous layer first pass 23 is thick or porosity is low, there is an inclination for the porosity of 22 to become high the second layer of the above-mentioned porous layer. for this reason -- if thickness of the above-mentioned porous layer first pass 23 is made thin, for example, for keeping the porosity of 22 high the second layer of the

above-mentioned porous layer -- a porous layer second -- formation of layer 22 -- it is necessary to make a current higher It is drawing 9 which showed this relation.

[0100] if -- formation of the second layer of a porous layer -- if a current is kept constant, and the thickness of the porous layer first pass changes, the porosity of the second layer of a porous layer will be influenced. Drawing 10 showed this relation. According to drawing 10 , it is related drawing of the porosity (%) of the second layer to first pass thickness (micron), and after forming the porous layer first pass, it is clear to affect the porosity whose property of the porous layer first pass is the second layer of a porous layer rather than to be able to to form the second layer of a porous layer independently of this. The detailed mechanism of such a phenomenon cannot be solved thoroughly. however, it mentions later -- as -- formation of Porosity Si -- formation -- F- in liquid ion needs -- having -- **** -- the hole formation section at the head of a hole -- F- if ion is consumed -- the hole from the front-face side of Porosity Si -- inside -- passing -- new F- Ion needs to be conveyed and it needs to be supplied at the head of a hole.

[0101] such a hole -- inner F- It is thought that it depends for the electric field of ion or the effectual mobility of transport by diffusion on the hole size of the first pass or the die length of a hole, i.e., the thickness of the first pass. That is, the porous layer first pass itself formed of anodization restricts transport of ion required for porous layer formation of the point.

[0102] Therefore, F which needs the formed porous layer first pass for formation of the porous layer of the point - It works as an effectual mobility limit layer of ion transport. formation -- if a current is fixed, formation runs, without porosity seldom changing to considerable thickness. This is F at a fixed current. - Although the hole of a certain size decided by consumption of ion and balance of supply is formed, when a current is increased on the way, it is F by existence of a porous layer [finishing / formation / already]. - It thinks for consumption of ion and the balance of supply to change and for the size of a hole to change a lot.

[0103] F to which the thickness of the first pass increases and the inside of it is conveyed - If the effectual mobility of ion goes down F- in the head of a hole ion concentration -- falling -- the formation of the holes -- an ion lack layer spreads in liquid -- formation -- Si is etched for the part to which the potential barrier of the interface of liquid and Si single crystal front face in a hole becomes low breadth and there, and the size of a hole may be increasing.

[0104] actually -- formation -- if a mobility limit layer does not exist in Si front face even if it enlarges a current simply -- porosity -- not much -- not increasing -- rather -- formation -- a rate will increase. therefore, formation -- the case where it is going to change porosity a lot according to buildup of a current -- a porosity buildup layer and formation -- certain F- above, between liquid The mobility limit layer of ion is required. Then, if thickness of the above-mentioned porous layer first pass is made thickly around a base, the porosity of the second layer of the porous layer of the part can be made larger than the porosity whose thickness of the first pass of a center section is the second layer of a thin part, and it will become possible to weaken the mechanical strength of the isolation region of a base periphery by this.

[0105] This invention has the big description also in the point which can make the porosity of the layer 22 with said large porosity at a periphery larger than the center section of the base, when the mechanism of anodization is skillfully used for this appearance, and forming said isolation region which consists of a field of the shape of two or more layer where said mechanical strengths differ and said porosity makes thickness of the small layer 23 at a periphery larger than the center section of the base.

[0106] And a porous layer can be formed in a wafer by the anodization approach using simple equipment as shown in drawing 4 as mentioned above. In this way, it is possible to make thickness of the base periphery of a layer with small porosity thicker than a base center section, and to make larger than the porosity of a base center section the porosity of the base periphery of a layer with the big porosity which this forms after that. When distribution of such an inrush current needs to be further controlled to a precision, the current guide which controls the ion current distribution which flows into a base front face near the base to degas can be prepared, and distribution of the thickness of a layer with said small porosity can be controlled by controlling ion current distribution.

[0107] Moreover, it is as having shown and explained the water jet fuel injection equipment for separating a wafer and a thin film semiconductor from the compound member of the first base and the second base to above-mentioned drawing 7 .

[0108] Next, drawing 8 is drawing for explaining in detail an example of the structure of the lamination base which can be used for the approach of this invention, as mentioned above. In this example, the isolation region 3 has from this the two-layer structure with high porosity which mechanical strength becomes from 22 the second layer of weak porosity with the porosity first pass 23 with low porosity, as shown in drawing 8 . In this invention, the second layer of the above-mentioned porosity, 22 makes porosity near the periphery of a base higher than a center section, or should just thicken the thickness. A crack produces separation in the inside of 22, or its interface the second layer of the porosity in a different location from a lamination interface. The second layer of porosity, since the mechanical strength is weak, if the force is added in the direction which the first base 21 and second base 27 separate, only 22 will be destroyed the second layer of porosity and both will separate 22. In case the layer 4 which the porosity first pass 23 turns into from the nonvesicular single crystal Si at this time is formed, in order to suppress generating of a crystal defect, it is required for a layer 4 as a protective layer for destruction not to reach at a separation process. It is better for the yield to have 22 the second layer of porosity preferably, although it is also possible to dissociate without forming 22 the second layer of porosity if porosity is not made so high, of course.
[0109]
[Example] Next, each example explains the content of this invention still more concretely.
[0110] In [example 1] this example, anodization was performed for the 1st single crystal (100) Si substrate of the diameter of 8 inch of the P type (or N type may be used) with the thickness of 625 micrometers of specific resistance 0.01 ohm-cm into HF solution. formation of anode plate-ized stratification -- ****** was created so that the cross section of a field parallel to an electrode and the above-mentioned Si single crystal base might be changed with the twice [about] of the area of this Si base, and this was used.
[0111] The anodization conditions are as follows.
[0112] formation -- current: -- 2.6 (A)
anodization solution: -- HF:H2 O:C2 H5 OH=1:1:1 hour: -- 11 (minute)
thus, the thickness of the center section of the porous layer of the degassed base -- the porosity of a center section was [the porosity of the thickness of the porous layer of a periphery] 30% in about 19 microns at the maximum about 20% at about 12 microns. Although created on such conditions, electron microscope observation can investigate the magnitude of the hole of a periphery, and it is [part / deep / center section] clearly large from a front face. However, near the front face of a porous layer, the difference with a center section or a periphery remarkable in the magnitude of a hole is not seen. This is dramatically important when carrying out epitaxial growth of the single crystal of Si with few defects to the shape of a porous layer at a next process.
[0113] This substrate was oxidized at 400 degrees C among the oxygen ambient atmosphere for 1 hour. The wall of the hole of Porosity Si was covered with this oxidation by the thermal oxidation film. It washed by fluoric acid, and after performing 950-degree C heat treatment in a hydrogen ambient atmosphere subsequently, 0.3 micrometers grew the single crystal Si epitaxially with the CVD method of the following conditions on Porosity Si.
[0114] source gas: -- SiH4 carrier gas: -- H2 temperature: -- 900-degree-C pressure: -- 1x10-2Toor growth rate: -- it formed 100nm SiO two-layer in this epitaxial Si layer front face by thermal oxidation further 3.3 nm/sec.
[0115] This SiO2 Superposition and after making it contact, heat treatment for 5 minutes was carried out for the layer front face and the front face of Si substrate prepared independently at 1180 degrees C, and lamination was performed. It set in the equipment which showed the compound member to drawing 7 , when water jet injection was performed on water pressure 1000 kgf/cm2 and conditions with a diameter of 0.15mm, the porosity Si layer fractured, the wafer was halved good and Porosity Si expressed [two Si substrates] it to the separation side. Then, selective etching of the porosity Si layer is carried out with the etching reagent of HF/H2O2 / C2H5OH system. Selective etching of the porosity Si was carried out, and it was removed thoroughly. The etch rate to this etching of a nonvesicular Si single crystal is very low, and the amount of etching in a nonvesicular layer can be disregarded practically. That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film has been formed. It was changeless in a single crystal Si layer in any way also by the selective etching of Porosity Si.

[0116] In this way, the obtained SIO substrate was heat-treated in the hydrogen ambient atmosphere.
[0117] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained. The same result is obtained even if it does not form an oxide film in an epitaxial Si layer front face. 1st Si single crystal substrate removed the residual porosity Si, and in order to obtain one more SOI substrate, it used it as 1st Si single crystal substrate again.
[0118] In [example 2] this example, anodization is performed for the 1st single crystal (100) Si substrate of the diameter of 8 inch of the P type (or N type may be used) with the thickness of 625 micrometers of specific resistance 0.01 ohm-cm into HF solution. formation of anode plate-ized stratification -- ****** was created so that the cross section of a field parallel to an electrode and the above-mentioned Si single crystal base might be changed with the twice [about] of the area of this Si base, and this was used.
[0119] The anodization conditions are as follows.
[0120] formation -- current: -- 2.6 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 11 (minute)
Thus, in the thickness of the center section of the porous layer first pass of the degassed base, the porosity of a center section became about 20% by about 12 microns. The porosity of the thickness of the porous layer of a periphery was 30% in about 19 microns at the maximum. then, the first pass -- formation -- the second-layer formation is succeedingly performed on condition that the following the back.
[0121] Current density: 8 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 2 (minute)
When the second-layer formation was performed on the above conditions after first pass formation, the thickness of the center of the second layer became about 2 microns, and porosity became about 40%. However, in the periphery of a base, porosity is about a maximum of 55%, and the thickness is less than 2 microns.
[0122] However, near the front face of the porous layer first pass, the difference with a center section or a periphery remarkable in the magnitude of a hole is not seen. This is dramatically important when carrying out epitaxial growth of the single crystal of Si with few defects to the shape of a porous layer at a next process.
[0123] This substrate was oxidized at 400 degrees C among the oxygen ambient atmosphere for 1 hour. The wall of the hole of Porosity Si was covered with this oxidation by the thermal oxidation film. Next, HF solution washes, and after heat-treating in a hydrogen ambient atmosphere, 0.3 micrometers grows a single crystal Si epitaxially with a CVD method on Porosity Si. The growth conditions were as follows.
[0124] source gas: -- SiH4 carrier gas: -- H2 temperature: -- 900-degree-C pressure: -- 1x10-2Torr growth rate: -- it formed 100nm SiO two-layer in this epitaxial Si layer front face by thermal oxidation further 3.3 nm/sec.
[0125] This SiO2 Superposition and after making it contact, heat treatment for - 5 minutes is carried out for a layer front face and the front face of Si substrate prepared independently at 1180 degrees C, and lamination is performed. In this way, the typical sectional view of the obtained compound member is shown in drawing 11 . As for the compound member, according to drawing 11 , 22 shows the condition of consisting a layer of a part for a center section 33 and its circumference part 34 of 22 parts for a center section 35 and the circumference parts 36 of nothing and the porosity first pass 23, and the second layer of porosity, between the first base 1 and the second base 2, respectively an oxide film 6, the single crystal Si layer 4, the porosity first pass 23, and the second layer of porosity.
[0126] When the wafer end face was made to express a porous layer, Porosity Si was etched to some extent and the sharp plate was inserted there like the cutting edge of a razor by this drawing 11 , the porosity Si layer fractured, the wafer was halved and Porosity Si expressed it. Then, selective etching of the porosity Si layer is carried out with the etching reagent of HF/H2 O2 / C2H5OH system. Selective etching of the porosity Si was carried out, and it was removed thoroughly. The etch rate to this etching reagent of a nonvesicular Si single crystal is very low, and the amount of etching in a nonvesicular layer is thickness reduction which can be disregarded practically. That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film has been formed. It was changeless in a single crystal Si layer in any way also by the selective etching of Porosity Si. In this way, the obtained SOI substrate

was heat-treated in the hydrogen ambient atmosphere.
[0127] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained. The same result was obtained even if it did not form an oxide film in the epitaxial Si layer front face. 1st Si single crystal substrate removed the residual porosity Si, and used it as 1st Si single crystal substrate again.
[0128] In [example 3] this example, anodization was performed for the 1st single crystal (100) Si substrate of the diameter of 8 inch of the P type (or N type may be used) with the thickness of 625 micrometers of specific resistance 0.01 ohm-cm into HF solution. formation of anode plate-ized stratification -- ****** was created so that the cross section of a field parallel to an electrode and the above-mentioned Si single crystal base might be changed with the twice [about] of the area of this Si base, and this was used.
[0129] The anodization conditions are as follows.
[0130] formation -- current: -- 2.6 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 11 (minute)
thus, the thickness of the center section of the porous layer first pass of the degassed base -- the porosity of a center section was [the porosity of the thickness of the porous layer of a periphery] 30% in about 19 microns at the maximum about 20% at about 12 microns. the first pass -- formation -- the second-layer formation was succeedingly performed on condition that the following the back.
[0131] Current density: 8 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 2 (minute)
When the second-layer formation was performed on the above conditions after first pass formation, the thickness of the center of the second layer was about 2 microns, and porosity was about 40%. However, in the periphery of a base, porosity was about a maximum of 55%, and the thickness was less than 2 microns.
[0132] However, near the front face of the porous layer first pass, the difference with a center section or a periphery remarkable in the magnitude of a hole is not seen. This is dramatically important when carrying out epitaxial growth of the single crystal of Si with few defects to the shape of a porous layer at a next process.
[0133] This substrate was oxidized at 400 degrees C among the oxygen ambient atmosphere for 1 hour. The wall of the hole of Porosity Si was covered with this oxidation by the thermal oxidation film. HF solution washes, and after heat-treating in a hydrogen ambient atmosphere, 0.3 micrometers grows a single crystal Si epitaxially with a CVD method on Porosity Si. The growth conditions are as follows.
[0134] source gas: -- SiH4 carrier gas: -- H2 temperature: -- 900-degree-C pressure: -- 1x10-2Torr growth rate: -- it formed 100nm SiO two-layer in this epitaxial Si layer front face by thermal oxidation further 3.3 nm/sec.
[0135] This SiO2 Superposition and after making it contact, heat treatment for 5 minutes is carried out for a layer front face and the front face of Si substrate prepared independently at 1180 degrees C, and lamination is performed. In this way, a compound member like drawing 11 mentioned above was obtained. When water jet injection is carried out to a wafer side face on water pressure 300 kgf/cm2 and conditions with a diameter of 0.1mm, a porosity Si layer fractures, a wafer is halved very good and Porosity Si expresses it. Then, selective etching of the porosity Si layer is carried out with the etching reagent of HF/H2O2 / C2H5OH system. Selective etching of the porosity Si was carried out, and it was removed thoroughly. The etch rate to this etching reagent of a nonvesicular Si single crystal is very low, and the amount of etching in a nonvesicular layer is thickness reduction which can be disregarded practically. That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film has been formed. It was changeless in a single crystal Si layer in any way also by the selective etching of Porosity Si. In this way, the obtained SOI substrate was heat-treated in the hydrogen ambient atmosphere.
[0136] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained. The same result was obtained even if it did not form an oxide film in the epitaxial Si layer front face. 1st Si single crystal substrate removed the residual porosity Si, and used it as 1st Si single crystal substrate

again.
[0137] In [example 4] this example, anodization was performed for the 1st single crystal (100) Si substrate of the diameter of 8 inch of the P type with the thickness of 625 micrometers of specific resistance 0.01 ohm-cm, or N type into HF solution. formation of anode plate-ized stratification -- ****** was created so that the cross section of a field parallel to an electrode and the above-mentioned Si single crystal base might be changed with about 1.3 times of the area of this Si base, and this was used.
[0138] The anodization conditions are as follows.
[0139] formation -- current: -- 2.6 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 11 (minute)
Thus, the porosity of a center section of the thickness of the center section of the porous layer first pass of the degassed base was about 20% in about 6 microns. The porosity of the thickness of the porous layer of a periphery was 25% in about 8 microns at the maximum. the first pass -- formation -- the second-layer formation is succeedingly performed on condition that the following the back.
[0140] Current density: 12 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 1 (minute)
Near the front face of the porous layer first pass, the difference with a center section or a periphery remarkable in the magnitude of a hole is not seen. This is dramatically important when carrying out epitaxial growth of the single crystal of Si which does not have a defect on a porous layer at a next process.
[0141] This substrate was oxidized at 400 degrees C among the oxygen ambient atmosphere for 1 hour. The wall of the hole of Porosity Si was covered with this oxidation by the thermal oxidation film. HF solution washes, and after heat-treating in a hydrogen ambient atmosphere, 0.3-micrometer epitaxial growth of the single crystal Si was carried out with the CVD method on Porosity Si. The growth conditions are as follows.
[0142] source gas: -- SiH4 carrier gas: -- H2 temperature: -- 900-degree-C pressure: -- 1x10-2Torr growth rate: -- it formed 100nm SiO two-layer in this epitaxial Si layer front face by thermal oxidation further 3.3 nm/sec.
[0143] Superposition and after making it contact, heat treatment for 5 minutes was carried out for this SiO two-layer front face and the front face of Si substrate prepared independently at 1180 degrees C, and lamination was performed. If water jet injection is performed on water pressure 300 kgf/cm2 and conditions with a diameter of 0.1mm there, without making a wafer end face express a porous layer, and etching Porosity Si to some extent, a porosity Si layer fractures, a wafer will be halved very good and Porosity Si will express it. Then, selective etching of the porosity Si layer was carried out with the etching reagent of HF/H2O2 / C2H5OH system. By time amount shorter than an example 3, selective etching of the porosity Si was carried out, and it was removed thoroughly. The etch rate to this etching reagent of a nonvesicular Si single crystal is very low, and the amount of etching in a nonvesicular layer is thickness reduction which can be disregarded practically. That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film has been formed. It is changeless in a single crystal Si layer in any way also by the selective etching of Porosity Si. In this way, the obtained SOI substrate was heat-treated in the hydrogen ambient atmosphere.
[0144] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained. The same result was obtained even if it did not form an oxide film in the epitaxial Si layer front face. 1st Si single crystal substrate removed the residual porosity Si, and used it as 1st Si single crystal substrate again.
[0145] In [example 5] this example, anodization is performed for the 1st single crystal (100) Si substrate of the diameter of 8 inch of the P type (or N type may be used) with the thickness of 625 micrometers of specific resistance 0.01 ohm-cm into HF solution. formation of anode plate-ized stratification -- ****** was created so that the cross section of a field parallel to an electrode and the above-mentioned Si single crystal base might be changed with about 1.3 times of the area of this Si base, and this was used.
[0146] The anodization conditions are as follows.
[0147] formation -- current: -- 2.6 (A)

anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 11 (minute)
Thus, for the thickness of the center section of the porous layer first pass of the degassed base, the porosity of a center section was [about 8 microns and the porosity of the thickness of the porous layer of a periphery] 25% at the maximum about 20% in about 6 microns. the first pass -- formation -- the second-layer formation was succeedingly performed on condition that the following the back.
[0148] Current density: 12 (A)
anodization solution: -- HF:H2 O:C2H5OH=1:1:1 hour: -- 1 (minute)
Near the front face of the porous layer first pass, the difference with a center section or a periphery remarkable in the magnitude of a hole is not seen. This is dramatically important when carrying out epitaxial growth of the single crystal of Si with few defects on a porous layer at a next process.
[0149] This substrate was oxidized at 400 degrees C among the oxygen ambient atmosphere for 1 hour. The wall of the hole of Porosity Si was covered with this oxidation by the thermal oxidation film. HF solution washes, and after heat-treating in a hydrogen ambient atmosphere, 0.3-micrometer epitaxial growth of the single crystal Si was carried out with the CVD method on Porosity Si. The growth conditions were as follows.
[0150] source gas: -- SiH4 carrier gas: -- H2 temperature: -- 900-degree-C pressure: -- 1x10-2Torr growth rate: -- it formed 100nm SiO two-layer in this epitaxial Si layer front face by thermal oxidation further 3.3 nm/sec.
[0151] Superposition and after making it contact, heat treatment for 5 minutes is carried out for this SiO two-layer front face and the front face of Si substrate prepared independently at 1180 degrees C, and lamination is performed. A wafer end face is made to express a porous layer, and Porosity Si is etched to some extent. in this way, it created -- many -- when the lamination base of several sheets was sunk into the cistern of simultaneous supersonic-wave irradiation equipment and the about 50kHz supersonic wave was irradiated, the porosity Si layer of all lamination bases broke, the wafer was halved at once and Porosity Si expressed it. Then, selective etching of the porosity Si layer is carried out with the etching reagent of HF/H2O2 / C2H5OH system. By time amount shorter than an example 3, selective etching of the porosity Si is carried out, and it is removed thoroughly. The etch rate to this etching reagent of a nonvesicular Si single crystal is very low, and the amount of etching in a nonvesicular layer is thickness reduction which can be disregarded practically. That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film has been formed. It is changeless in a single crystal Si layer in any way also by the selective etching of Porosity Si.
[0152] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained. The same result was obtained even if it did not form an oxide film in the epitaxial Si layer front face. 1st Si single crystal substrate removed the residual porosity Si, and used it as 1st Si single crystal substrate again.
[0153] In [example 6] this example, the oxide film (SIO2 layer) of 200mn(s) was formed in the 1st single crystal Si substrate front face by thermal oxidation as an insulating layer.
[0154] The first ion implantation was performed from the 1st substrate front face so that projection range might come into Si substrate here. Of this, the layer which works as an isolation region was formed in the place of the depth of projection range as a distortion layer by the very small air-bubbles layer or the impregnation ion kind high concentration layer. The ion implantation was again performed in the range of 10mm of peripheries of a substrate on the almost same conditions as the first time after this. Thereby, the amount of ion implantations of a periphery became twice [about] a center section.
[0155] After the above-mentioned ion implantation and this SiO2 The layer front face and the front face of 2nd Si substrate prepared independently were heat-treated at the temperature of 600 degrees C, after making it contact, superposition and, and lamination was performed.
[0156] Holding in a core the lamination substrate formed as mentioned above, and rotating it around a medial axis, when water jet injection was performed to parallel on water pressure 300 kgf/cm2 and conditions with a diameter of 0.1mm from the periphery in the lamination side, said isolation region broke and the wafer was separated very good.
[0157] Consequently, SiO2 formed in the first base front face from the first The remaining part of a detached core remained in the 1st substrate front face on which a part of layer, surface single crystal

layer, and detached core were transferred to the 2nd substrate side. The 2nd substrate of the backward above of the above-mentioned separation was annealed at 1000 degrees C, CMP equipment ground and removed the detached core transferred on the 2nd substrate after that, and the front face was graduated.
[0158] That is, the single crystal Si layer which had the thickness of 0.2 micrometers on Si oxide film can be formed. In this way, when the thickness of the single crystal Si layer formed on the done insulating layer was measured about the whole surface within a field in the 100-point location, the homogeneity of thickness was 201nm**7nm.
[0159] As a result of the cross-section observation by the transmission electron microscope, a new crystal defect was not introduced into Si layer, but it was checked that good crystallinity is maintained.
[0160] When it furthermore heat-treated at 1100 degrees C in hydrogen for 1 hour and the atomic force microscope estimated surface roughness, the 2nd [an average of] power granularity in the field of 50-micrometer angle was equivalent to Si wafer usually marketed by about 0.2nm.
[0161] The same result is obtained, whether it forms an oxide film in the 2nd substrate front face instead of an epitaxial layer front face or forms in the both.
[0162] Moreover, the detached core which remained in the 1st substrate side can be reproduced by etching and surface polish, surface treatment, such as hydrogen annealing, can be performed further if needed, and it can supply as the 2nd substrate as the 1st substrate again.
[0163] Although this example is an example which relocates the surface field of Si wafer to the 2nd base through the detached core by the ion implantation from the first, it may transfer an epitaxial layer to the 2nd substrate through the detached core by the ion implantation using an epitaxial wafer. Moreover, it is a front face SiO_2 after the ion implantation of this example. After removing, an epitaxial layer is formed, and it is SiO_2 further. It may form and close may transfer an epitaxial layer to a lamination process through the detached core by the ion implantation the back at the 2nd substrate. As for the case of the latter, the surface field of Si wafer will also be relocated from the first.
[0164]
[Effect of the Invention] When according to each above-mentioned example separating a compound member and separation advances inside from the edge section of a lamination base even if it makes the force for separation high, both both [one of the two or] which were separated to the middle break.
[0165] Moreover, it can prevent that the particle which an isolation region collapses and generates pollutes a process. Moreover, the yield of separation can be improved also when it is going to dissociate by other approaches without using a fluid.
[0166] Furthermore, when separating a base from the isolation region made by the compound member of the stuck semi-conductor base and others, at an intermediate process, separation does not take place but the compound member suitable for dissociating certainly can be formed in a separation process.

[Translation done.]

* NOTICES *

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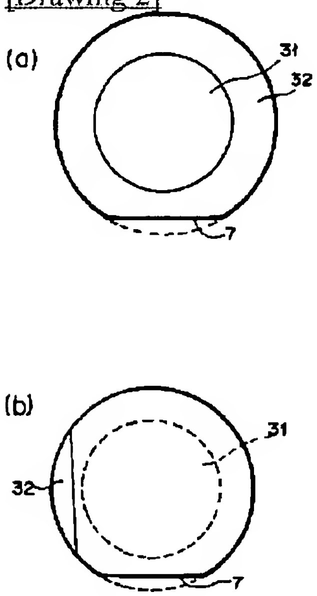
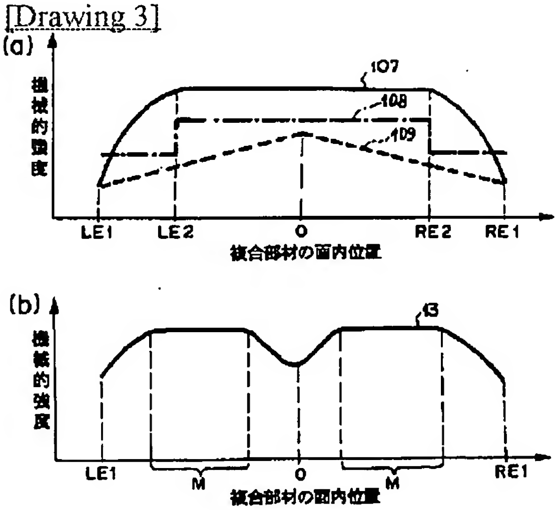
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

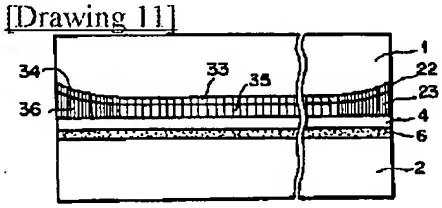
[Drawing 2]



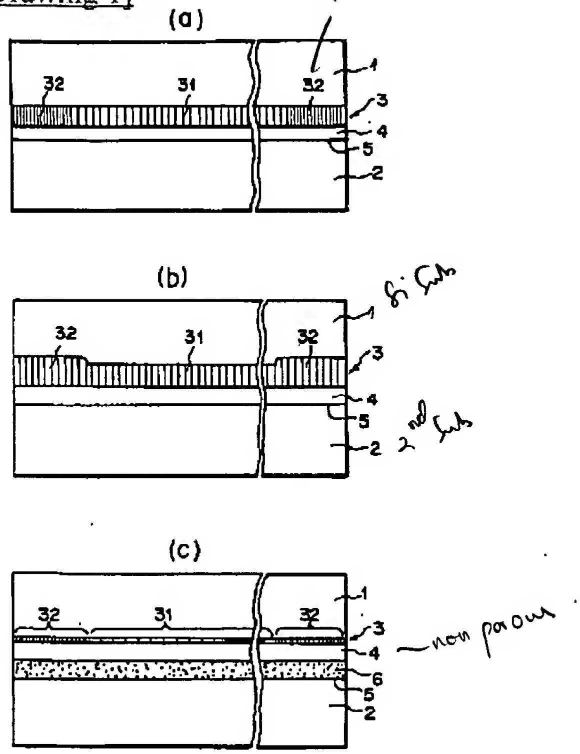
[Drawing 3]



[Drawing 11]



[Drawing 1]



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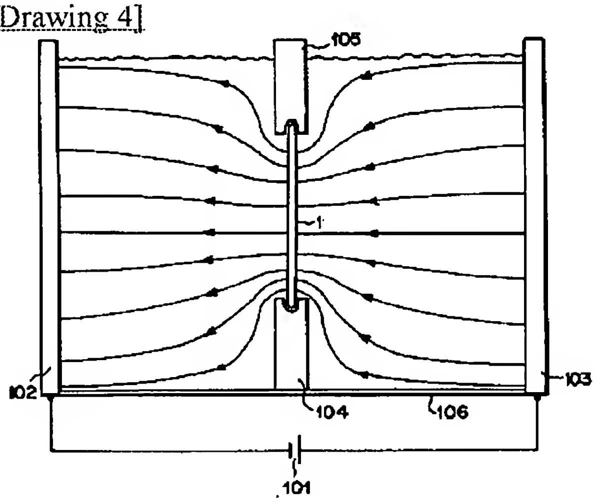
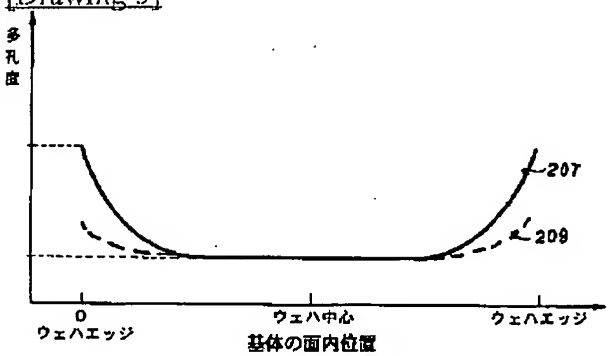
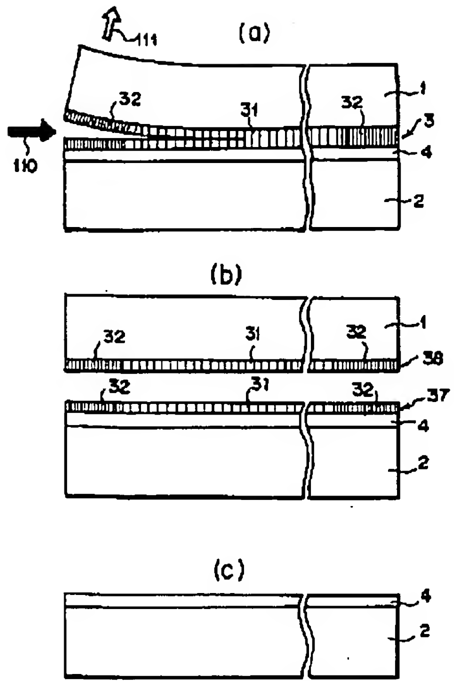


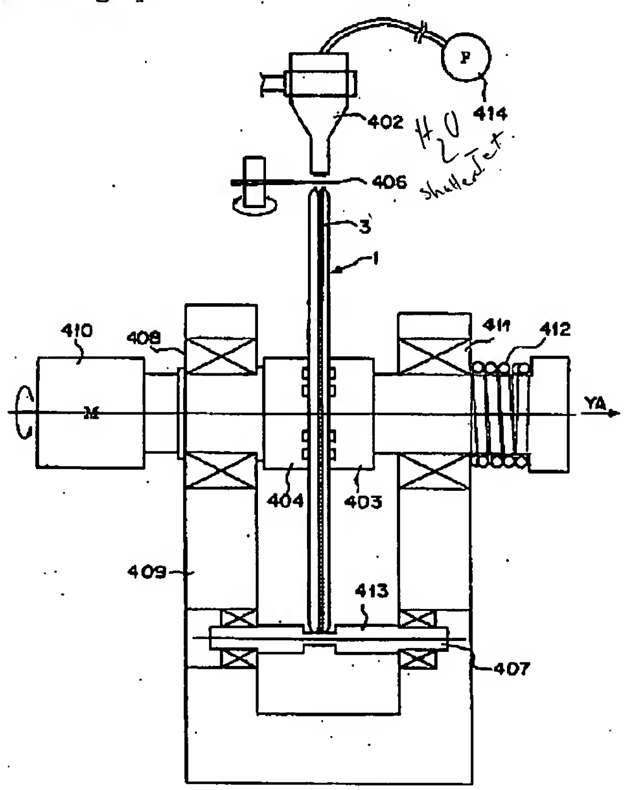
[Drawing 5]



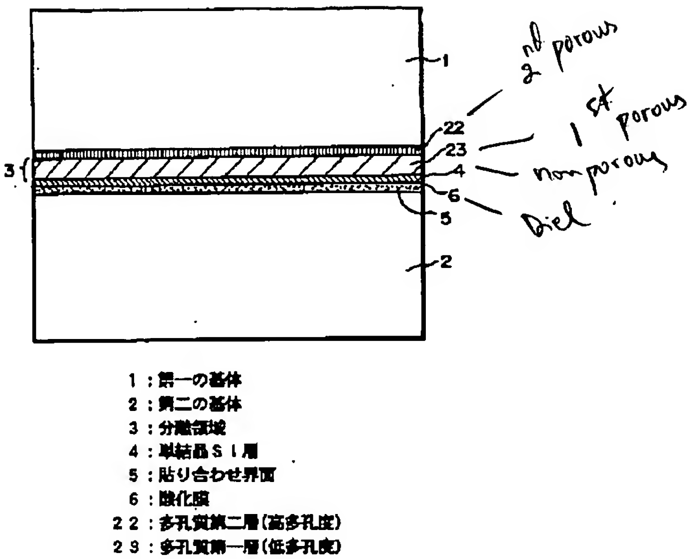
[Drawing 6]



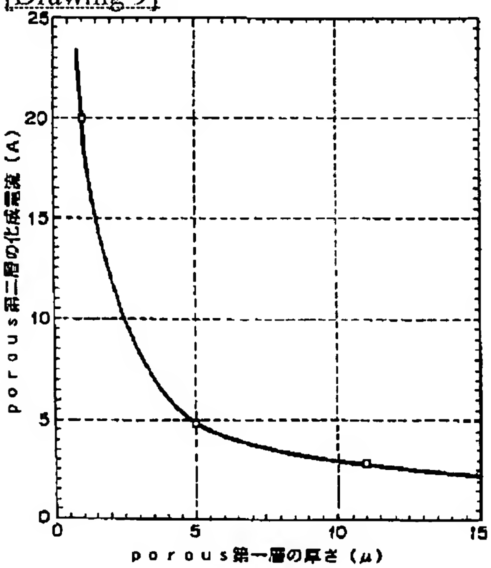
[Drawing 7]



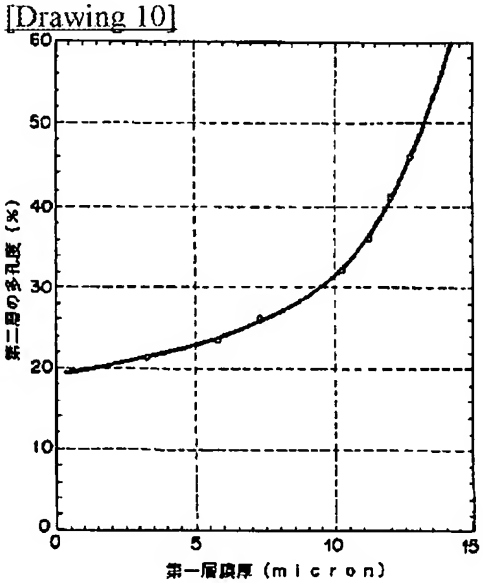
[Drawing 8]



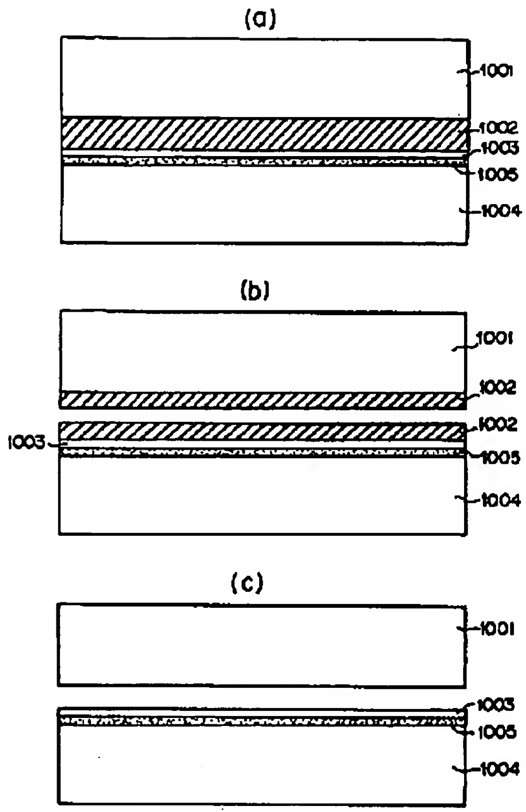
[Drawing 9]



[Drawing 10]



[Drawing 12]



[Translation done.]